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Underground pumped storage hydropower (UPSH) and its interaction with the saturated subsurface medium: effects of the water exchanges on the environment and the plant efficiency

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Underground pumped storage hydropower (UPSH) is an alternative energy storage system (ESS) for flat regions, where conventional pumped storage hydropower plants cannot be constructed due to topographical limitations. UPSH plants consist in two reservoirs, the upper one is located at the surface or possibly underground (but at shallow depth) while the lower one is underground. Although the underground reservoir can be drilled, the use of abandoned mines (deep or open pit mines) as underground reservoir is a more efficient alternative that is also beneficial for local communities after the cessation of mining activities. Given that mines are rarely waterproofed, water exchanges between UPSH plants and the underground medium are expected. Water exchanges may have negative consequences for the environment, but also for the feasibility of UPSH plants. The impacts on the environment and the plant efficiency may have hydraulic (changes of the natural piezometric head distribution, effects in the hydraulic head difference between the two reservoirs, etc.) or hydrochemical nature (dissolution and/or precipitation of minerals in the aquifer and in the reservoirs, corrosion of facilities, modification of pH, etc.). At this stage, it is required a sound understanding of all the impacts produced by the water exchanges and evaluate under which circumstances they are mitigated. This assessment will allow ascertaining criteria for the selection of the best places to construct future UPSH plants.